

Multi-Scale Variability of Orographic Precipitation and Topographic Attributes: Application to Rainfall Downscaling

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Precipitation downscaling requires a priori knowledge of the way rainfall statistics vary across scales in space and time. For orographic rainfall, these statistics are influenced by the interaction of the larger scale meteorological forcing with the underlying terrain. In this study we use wavelet-based multiresolution analysis to determine the signature that topography leaves on the multiscale structure of rainfall fields. We propose that at spatial scales on the order of 10 km and larger, rainfall variability can be resolved by a convolution with topography, where the convolution filter is parameterizable in terms of a suite of location- and storm-dependent meteorological variables. At scales less than 10 km, rainfall variability is explained statistically using an almost universal multiscale filter that operates on topography gradients. The proposed approach is tested using both observed orographic rainfall with ground-based radars and simulated rainfall from high resolution cloud resolving models over the Appalachian mountains. The challenge of temporal downscaling is also addressed.